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CHEMICAL AGENT DELIVERY DEVICE AND METHOD OF USING SAME

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CHEMICAL AGENT DELIVERY DEVICE AND METHOD OF USING SAME

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial Number 60/262,417, filed January 19, 2000 by David Robinson, et al., the entire disclosure of which is hereby incorporated by reference in its entirety. This application relates to U.S. Provisional Patent Application No. 60/323,386, filed September 20, 2001, and U.S. Provisional Patent Applications No. 60/293,175, filed May 25, 2001, the entire disclosures of which are incorporated herein by reference.

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FIELD OF THE INVENTION

[0003] The present invention relates in general to the field of chemical agent delivery devices, and, in particular, provides a device which can deliver pesticides to a target from a safe distance by firing encapsulated pesticide at a target.

BACKGROUND OF THE INVENTION

[0004] Insects, and the damage they cause, are a serious economic threat to fruit and vegetable farmers worldwide. For example, importing countries will block fruit and vegetable shipments from certain exporting countries, rather than risk their phytosanitary status by importing foreign fruits and vegetables.

[0005] One type of insect that is of major concern is the fruit fly. There are over 4,000 species of fruit flies worldwide today. The genus *Anastrepha*, found throughout the Americas, Florida and the Caribbean Islands, comprises approximately 180 species. Of these 180 species, 7 have been known to cause serious economic damage.

[0006] The *Ceratitis Capatata*, commonly known as the Mediterranean Fruit Fly (Medfly), is the most widespread and damaging fruit fly in the world. The Medfly can currently be found in Guatemala and the Mexican states bordering Guatemala. If the Medfly reaches Oaxaca and/or Veracruz, it will have a corridor to the United States. Countermeasures, particularly effective means of pest control, are needed to prevent the spread of the Medfly to the United States.

[0007] Chemical agents which are toxic, noxious, or otherwise harmful to Medflys are used in the effort to keep the Medfly from entering the United States, but such chemicals can also be highly toxic to human farmers, ranchers, veterinarians, and other pest control experts who routinely use such chemicals, and to beneficial animals, plants, and insects which may also come in contact with the chemicals. Some practitioners have appreciated the dangers faced by pest control experts when they dispense and apply chemical agents, and inventions exist that attempt to limit unnecessary chemical agent exposure. Some, such as those disclosed in U.S. Pat. No. 6,105,878 to Robinson et al., use ground-based systems to deliver liquid pesticides as a spray, using an optimal droplet size that reduces contamination to adjacent areas.

[0008] Liquid or powder chemical agents can also be sprayed from a helicopter or airplane. While such aerial chemical agent delivery means can cover large areas and treat widespread infestations, they have several disadvantages, including being subject to environmental effects and introducing chemical agents into areas which such chemical agents are not intended to reach. These disadvantages, in turn, can result in high chemical agent concentrations seeping into the soil or groundwater and causing long-term, wide-spread ecological damage or damage to animal or human populations.

[0009] Chemical agents can also be delivered through other means, such as bait stations. Bait stations can take several forms, but they generally function using the same basic principles. Bait stations are formed when a solid or viscous semi-liquid compound containing both an attractant and a chemical agent is placed in a location which is readily

accessible to a pest, such as the Medfly. A pest is attracted to the bait station by the attractant, and subsequently consumes or comes in contact with the chemical agent. Such chemical agent contact typically kills, neuters, or otherwise harms the pest, although bait stations are sometimes coated with animal or insect repellants. For example, fruit farmers will typically build bait stations by wrapping burlap or another fibrous material around the trunk of one or more trees in an orchard, and applying an attractant/pesticide compound to the fibrous material. The attractant attracts fruit flies, gypsy moth caterpillars, thrips, drywood termites, beetles, or other pests, and the pesticide typically kills the pest shortly after contact or ingestion.

[0010] While bait stations have some advantages over simple sprays or powders, they still present several disadvantages. For example, the attractant and chemical compound needs to be periodically replenished, which means that conventional bait stations must be located in a place which is accessible to the farmer or other pest control expert. This typically means that the bait stations are also accessible to other humans, as well as desirable or beneficial animals, plants, or insects. This can lead to contact or tampering with the bait stations, which can result in unintentional exposure to the chemical agents of the bait station.

[0011] Although chemical agents used in bait stations may only be lethal to a specific animal, plant, or insect, the chemical agents can still cause significant health problems in a beneficial or desirable animal, plant, or insect when they come into contact with or accidentally ingest the chemical agent. In addition, the lethality of some chemical agents is dependent on an anticipated exposure time, and repeated or extended exposure to some chemical agents, as may be experienced by a farmer, rancher, veterinarian, groundskeeper, or other pest control expert, can result in such chemical agents becoming lethal.

SUMMARY OF THE INVENTION

[0012] The present invention in its preferred embodiment provides a pesticide delivery apparatus and system, and methods of using such an apparatus. In accordance with one aspect of the present invention, one or more pesticides, such as an insecticide, germicide, fungicide, or herbicide, is encapsulated inside a flexible vessel, or capsule. Such a capsule will preferably be spherical in shape, and will be made from a biodegradable material, such as gelatin. Capsules can be fired from a pneumatic gun, similar to a conventional paintball gun. In the preferred embodiment, the capsule is fill with a gelatinous substance including both an attractant and a pesticide, and is fired directly to a location such as a tree or a canyon wall, thereby creating a bait station. Alternatively, the capsule can be delivered in the proximity or anticipated path of the pest.

[0013] In a preferred embodiment, capsules used in the present invention will have a caliber size, or diameter, of greater than 0.68 inches, preferably 0.73 inches. This size is preferred as it creates capsules which are too large to be fired by conventional paintball guns, thereby reducing the likelihood that a pesticide, insect repellant, or other chemical agent might be unintentionally fired at an opponent during a friendly paintball game.

[0014] To fire such a capsule, one aspect of the present invention provides for a modified pneumatic encapsulated chemical agent delivery device. In a preferred embodiment, such a device is comprised of several components, including a reservoir capable of holding at least one encapsulated chemical agent. A first cylindrical chamber, with a diameter greater than 0.68 inches, is operably connected to the reservoir, and at least one capsule can be conveyed from the reservoir into the first cylindrical chamber in preparation for firing the capsule. A compressed gas source is operably coupled to one end of the first cylindrical chamber and, when a trigger or other compressed gas release mechanism is pressed, compressed gas is released from the compressed gas source which causes capsule acceleration. The capsule speeds down a second cylindrical chamber, or barrel, which also has a diameter greater than 0.68 inches, and which is operably coupled

to the first cylindrical chamber. The barrel and first chamber may, alternatively, be portions of the same cylindrical chamber. After leaving the barrel, the capsule travels through the air or water and explodes on impact with a target.

[0015] Although firing capsules from a pneumatic gun is presently preferred, alternative delivery techniques are also envisioned. By way of example, without intending to limit the present invention, guns employing other means of accelerating a capsule prior to ejecting the capsule therefrom may be used. Such acceleration means include, but are not limited to, springs and other conventional projectile acceleration means. Alternatively, one or more capsules can be dropped from aircraft, allowing gravity to accelerate the capsules.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0017] In the drawings:

[0018] Figure 1 is a front elevational view of a gelatin capsule in accordance with an embodiment of the invention.

[0019] Figure 2 is a side elevational view of a pneumatic gun in accordance with an embodiment of the invention.

[0020] Figure 3 is a side elevational view of a pneumatic gun and gelatin capsule magazine in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[0022] A preferred embodiment of the present invention uses a pneumatic device, similar to the Typhoon paintball gun manufactured by Palmer Pursuit Shop of Sacramento, CA, to deliver chemical agents to a target. A pneumatic delivery device is presently preferred because of the high reliability and ease of service associated with pneumatic systems. A gun or rifle shape is currently preferred because of the increased accuracy of such delivery devices. Preferred pneumatic devices can accelerate capsules to speeds of 300 fps or more, allowing a farmer, veterinarian, rancher, or other pest control expert to deliver a chemical agent to a target from a safe distance. Although pneumatic, gun shaped delivery devices are preferred, other delivery devices, including, but not limited to, handheld slingshots, spring operated guns, and crossbow-like devices, electromagnetic guns and other known accelerating means can also be used without departing from the spirit or scope of the present invention.

[0023] In a preferred embodiment, the chemical agent is loaded into a capsule similar to a paintball capsule. Traditional paintball capsules are round, with a diameter of approximately .68 inches, and are made of soft gelatin. While gelatin is presently preferred, other capsule materials may be used, including, but not limited to, biodegradable materials, such as those made from plant fibers, and non-biodegradable capsule materials, such as thin plastics.

[0024] As described above, preferred delivery devices should be capable of accelerating a capsule to a velocity in excess of 300 fps when the capsule exits the gun. The 300 fps

speed is presently preferred because traditional gelatin paintball capsules typically cannot withstand accelerations necessary to increase capsule exit velocity. Use of alternative capsule materials may allow a delivery device to fire capsules at even higher speeds, resulting in even greater delivery distances.

[0025] It is presently preferred that capsules be designed to explode upon impact with a target, thereby delivering the chemical agent to the target. However, an alternative embodiment uses a semi-permeable capsule material, allowing the chemical agent to seep out over time. Such a material is disclosed in U.S. Provisional Patent Application No. 60/323,386, filed September 20, 2001, the entire disclosure of which is incorporated herein by reference. A semi-permeable capsule material can be coated with a thin layer of a relatively impermeable, biodegradable material, such as, but not limited to, gelatin, thereby allowing such capsules to be stored for longer periods of time.

[0026] Through the present invention, a pest control expert can deliver a chemical agent to a target without needing to physically contact the target, and from a greater distance than is possible with a spray. In addition, because the chemical agent is encapsulated, the effects of environmental conditions on chemical agent delivery can be mitigated, and chemical agents can be more accurately delivered than with conventional aerial distribution techniques. This also results in less chemical agent being introduced into the ecosystem, and can reduce the overall impact on the soil and groundwater.

[0027] The present invention can also be used to create or replenish a bait station. By way of example, without intending to limit the present invention, because the present invention can deliver chemical agents from a distance, the present invention can be used to position a bait station in a location that would otherwise be difficult to access on a regular basis. A capsule can be filled with a liquid, powder, viscous semi-liquid, or a more cohesive gelatinous chemical agent which can include a combination of one or more attractants, pesticides, repellants, or other compounds, which can subsequently be delivered to a target by firing the capsule at the target. Upon impact, the capsule bursts,

thereby delivering the chemical agent and creating or replenishing the bait station.

[0028] The present invention may also obviate the need for bait stations attached at specific locations. This can be advantageous for migratory pests, such as some insects. By delivering a chemical agent at or near the location of a pest, the present invention obviates the need to position fixed bait stations in the path of the pest, and can result in significant time saving.

[0029] Because the present invention can deliver a chemical agent from a distance, the present invention can also aid in the remote application of topical medicines and insect repellants on domestic, wild and feral captive species, such as animals in zoos or game preserves. An example of such a use would be the application of insect repellant to a herd of cattle. In such a scenario, one or more capsules containing a desired insect repellent can be fired at a cow, with capsules exploding on impact and delivering the insect repellent to the cow. Such an insect repellent delivery method would obviate the need to physically treat each cow in a herd.

[0030] In addition to its use as a detrimental chemical agent delivery means, the present invention can also deliver beneficial chemical agents, such as vitamins, medicines, water, food, and the like, to wild or feral animals. By way of example, without intending to limit the present invention, the pneumatic delivery system of the present invention can apply a liquid, powder, or a more cohesive gelatinous topical medicine to a vertebrate for skin or hide absorption.

[0031] In addition to delivering capsules associated with the present invention through ground-based delivery devices, the present invention additionally encompasses a method of dispensing capsules from an aircraft. In the aircraft embodiment, capsules can be ejected from a device mounted in the aircraft, such as a pneumatic delivery device, or capsules can be dropped from the aircraft, destined to burst upon impact with the desired target or the ground.

[0032] A preferred embodiment of the present invention involves firing a 0.73 gauge gelatin capsule, similar to the capsule illustrated in Figure 1, at a target, thereby delivering a chemical agent stored inside the capsule to the target. In this embodiment, the chemical agent in the capsule can be formulated for various purposes, including, but not limited to, attracting specific animals or insects through pheromones or food lures, stimulating feeding, acting as a killing agent, or combinations thereof. In addition, the mixture can be formulated to act as a female only attractant, male only attractant, or a male and a female attractant, and may only be attractive to a particular maturity level. The chemical agent can have an impact on the pest when the chemical agent is consumed or comes in contact with the pest.

[0033] Although capsules are preferably made from biodegradable materials, such as gelatin, other capsule materials may be substituted without departing from the spirit or scope of the invention. By way of example, without intending to limit the present invention, capsules may be made from low-gauge, relatively inert plastic when the chemical agent to be stored in the capsule may interact with other, more preferable materials. In addition, a capsule may be made from material containing, or may be coated with, a substance that makes the capsule unpalatable by giving the capsule an offensive taste or odor, thereby reducing the likelihood that the capsule will be accidentally ingested by an animal passing near the capsule. As capsules are prepared, they may be color-coded or labeled to identify the specific chemical agent formulation, target pest, use, expiration date, and the like contained therein.

[0034] A viscous, semi-liquid chemical agent which is designed to control or eradicate a specific pest species or group of pests in the same family or genus is presently the preferred chemical agent embodiment. While viscous, semi-liquids are preferred, other chemical agents, such as, but not limited to, solids, powders, liquids, or gases, can be employed using the present invention. As should be apparent to one skilled in the art, the components used in the capsule, their percentage or concentration, and their chemical/physical state will determine the effectiveness of the chemical agent. In

addition, factors such as chemical agent delivery location; pest population density; and host type, density, and condition, can also impact the effectiveness of the chemical agent. Thus, to achieve maximal results, regular chemical agent delivery may be advantageous. Chemical agent delivery frequency may be determined based upon a variety of factors, including the longevity of the chemical agent formulation, exposure to the elements, pest intensity, pest life cycle, and the like.

[0035] A preferred chemical agent embodiment uses capsules containing a chemical agent comprised of a mixture of 74.093% Polyethylene Glycol (PEG) 400, 4.499% Polyethylene Glycol (PEG) 6000, 2% glycerin, 3% water, 4.4% solulous AST, 12% dextrose anhydride, and 0.008 % spinosad. Such a water content is preferred because it does not prematurely dissolve a gelatin capsule. Such a chemical agent formulation may be useful in killing fruit flies, beetles, and other insects.

[0036] An alternative chemical agent embodiment uses a combination of SUCCESS (GF 120 and a spinosad concentration of 80 ppm), manufactured by Dow Agri Sciences, and water. This insecticide may be used to treat plants under attack from fruit flies, beetles, and other insects. Such a chemical agent can be obtained by mixing one gallon of SUCCESS with 1.5 gallons of water.

[0037] In another embodiment, capsules containing a mixture of Naled 52g, 10% (by weight) Dibrom 14 EC, Min – U – Gel, 23% (by weight) Min – U – Gel 400 and Male Lure 325 ml., 67% (by weight) methyl eugenol can be used to fight aphids, mites, mosquitoes, and other insects. Alternative concentrations of Min – U – Gel may be used to achieve better results.

[0038] In still another embodiment, capsules containing a mixture of Malathion, technical Grade 20% (by weight), Min – U – Gel, 13 % (by weight) Min – U – Gel 400 and Male Lure 325 ml., 67% (by weight) methyl eugenol can be used against mosquitoes and other insects. Additional amounts of Min – U -Gel may be required to achieve better results.

[0039] As the previous paragraphs indicate, capsules can be formulated to address several different types of vertebrate and invertebrate pest problems. Predetermined dosages can be utilized as animal repellants for the control of vertebrate pests attacking growing plants, stored grains, or bulk foods, and for establishing territorial markers to dissuade or exclude certain vertebrate or invertebrate species from approaching target areas or plant and animal hosts. By way of example, without intending to limit the present invention, fire-ants can be repelled or eradicated through the use of the present invention by delivering capsules directly into or onto ant-hills or directly onto masses of ants.

[0040] Capsule delivery can be achieved through a variety of means. In one embodiment, pneumatic delivery devices such as those illustrated in Figures 2 and 3, can deliver a capsule to a target. As Figures 2 and 3 illustrate, pneumatic delivery devices are preferably in the form of a pistol, rifle, or other firearm 10. Such a device should include a capsule staging area and barrel 40 capable of accommodating the capsule caliber and formulation. In addition, a preferred pneumatic delivery system should accommodate a magazine 20 capable of holding several capsules, which can be expelled individually or in groups under pressure from a compressed gas source 30.

[0041] A preferred pneumatic delivery device 10 comprises a pistol or rifle of the type known for projecting paintballs. In a preferred embodiment, the caliber of the pistol or rifle barrel 40 and the capsule loaded therein differs from standard paintball calibers so as to prevent use of the capsules of the invention with standard paintball guns. The pesticide-carrying capsules may range in a caliber size up to 1.0 inches for most agricultural applications, although larger caliber capsules may also be useful. A 0.73 inch caliber size is preferable, although any diameter larger than 0.68 inches is desirable as such a size exceeds the capacity of conventional paintball guns. In addition, larger diameter capsules can deliver a larger volume of chemical agents, thereby reducing the number of capsules needed to effectively treat a large area or large target population.

[0042] Such a pneumatic delivery system can fire capsules at targets, such as, but not limited to, bait stations, trees in an orchard or forest, crops in a field, individual pests, collections of pests, and individual or collections of desirable or beneficial animals. Such delivery can be made by an individual carrying a pneumatic delivery system, or such delivery systems can be mounted to vehicles, including, but not limited to, an all terrain vehicle, jeep, boat, or airplane. Preferred capsules can burst on impact with a target, thereby delivering the chemical agent to target.

[0043] While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to those skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.